

THE BRADSHAW LECTURE,

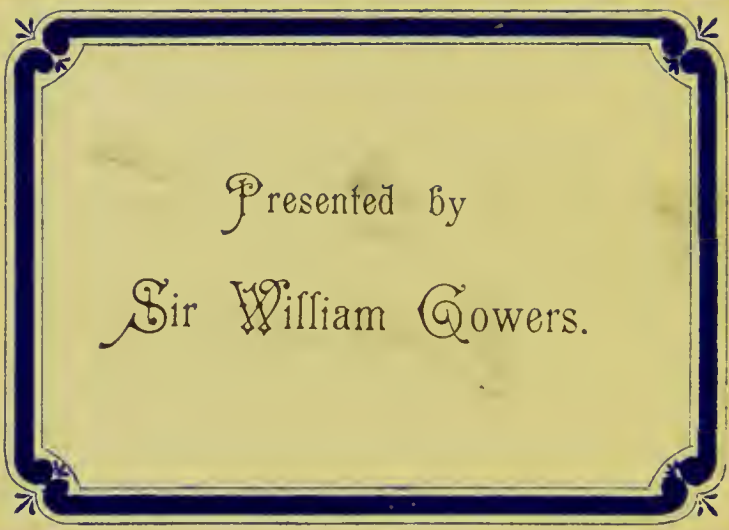
DELIVERED AT THE

ROYAL COLLEGE OF SURGEONS OF ENGLAND,

ON 3RD DECEMBER, 1891.

BY

J. W. HULKE, F.R.S.



Presented by
Sir William Gowers.



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J. W. HULKE, F.R.S.,

Vice-President of the College and Surgeon to the Middlesex Hospital.

ERRATA.

Page 18, line 5 from bottom *read* "classical" *for* "classified."

Page 46, line 11 from bottom *read* "masked" *for* "marked."

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THIS LECTURE IS PUBLISHED.

P R E F A C E .

THIS lecture is published substantially as delivered without alteration or addition. For readers who may wish to examine the evidence on which the views expressed in this lecture are founded, I append a selection, taken from my note-books, of cases illustrating the forms of injury of which it treats.

Those who are acquainted with the system prevalent in Metropolitan Hospitals, under which our House-Surgeons and dressers hold office only for short periods, rarely exceeding six months, will know the difficulty of securing methodical case-taking, and they will, I doubt not, make allowance for the fragmentary character of some of these narratives. As regards the facts stated, I have spared neither pains nor time to ensure their accuracy by closely controlling their observation and record.

J. W. H.

LONDON,

December, 1891.



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ON FRACTURES AND DISLOCATIONS OF THE VERTEBRAL COLUMN.

MR. PRESIDENT—Visitors, Fellows, and Members of our College, we meet here to-day to perpetuate the memory of William Wood Bradshaw, a former Member of the College, whose widow, as a token of her esteem and love, in order that her husband's name might long be remembered by us, founded, in his memory, a "*Lecture in Surgery, to be called the Bradshaw Lecture*"—to be delivered annually in this College, on the 16th day of August, being the anniversary of his death."

Falling as that day does in the autumn recess, when so many are absent from London, it was felt by our Council that Mrs. Bradshaw's pious intention would be better fulfilled by changing the date of the delivery of the lecture to a more convenient time, and this was accordingly done under proper legal sanction.

Of William Wood Bradshaw, and of his life's work, I cannot tell you anything that was not much better told in this theatre only a very few years ago by the first "Bradshaw Lecturer," Sir James Paget.

Beyond the narrow circle of his family, of his personal friends, and of his patients, William Wood Bradshaw appears to have been little known. That he was personally estimable, that his professional services were acceptable to his patients and valued by them, that he lived a life of honourable usefulness, we may rest assured; and we shall not be wrong in conceiving him to have been a good type of the country general practitioner, a worthy representative of that large band of quiet, unostentatious, meritorious workers, to the ranks of which our College contributes so largely.

Spread as they are throughout the length and breadth of the Empire, brought as they are into close, into intimate contact with persons in every grade of society, upon that which it knows, or imagines it knows, of that section of the medical profession engaged in family practice, the public largely founds its estimate of the whole profession.

If this is so, then, if the medical profession is to take and to maintain its true place in the social polity, in days when the increase and the diffusion of knowledge advance with such large and rapid strides, the importance of all its members being possessed of good general culture, in addition to the best technical information, cannot be over-estimated.

For the acquisition of better technical equipment at the beginning of the medical career, the approaching extension of the curriculum of study in the medical schools may do much if wisely employed. It is, I suggest, a matter of very great moment that this additional year of pupilage should be chiefly spent in clinical work, and thoroughness rather than multiplicity of subjects should be insisted on. The opinion that a large part of the additional year of study may be most profitably spent under the tutelage of a general practitioner finds favour with many. It cannot be doubted that this plan would have some advantages, but it appears to me not free from defects, and, after six months' absence from his hospital and school, I fear the candidate would be at a disadvantage when he presented himself at the final examination; moreover, I cannot quite discard the apprehension that many more would drift away into the ranks of the "unqualified assistant" than under the existing regulations of study. My strong conviction is that the advanced student will best employ his fifth year in hospital clinical work.

Happy is it for the individual when the habit of study acquired during pupilage is never afterwards laid aside, as it too often would seem to be when the daily routine of a

medical life begins to press. It is then that the aphorism that "refreshment is to be found in change of occupation, not in inaction," proves its truth, then that an intelligent interest in some subject apart from professional matters will often greatly help to relieve harass of mind, and assist to forget fatigue of body. It is a matter of congratulation to find an increasing number of the members of the medical profession taking an active interest, if only as amateurs, in art, in literature, and in many of the branches of science comprised under the quaint, old-fashioned, but significant term, "natural knowledge."

Within the single limitation that the Lecture must be surgical, Mrs. Bradshaw's bequest leaves the lecturer unfettered in the selection of his subject; and thus it has happened that, in successive years, we have heard Sir James Paget discourse on "*Some New and Rare Diseases*;" Mr. John Marshall, on "*Nerve-stretching for Pain*;" Sir Wm. Savory, on "*The Pathology of Cancer*;" Mr. John Wood, on "*Antisepsis in Surgery*;" Mr. H. Power, on "*Bacteriology, and its Relation to Surgery*;" Sir Joseph Lister, on "*Antiseptic Surgery*;" Mr. Jonathan Hutchinson, on "*Museums in their Relations to Medical Education and to the Progress of Knowledge*;" to our President, Mr. Bryant, on "*Colotomy*;" and to Sir Spencer Wells, on "*Modern Abdominal Surgery*."

But this freedom brings its difficulties; and the choice of a subject suitable to this occasion I found no easy task. Recognising that in all the lectures given here we should, so far as we can, utilise the resources of our museums, I turned to these for a suggestion, and in the series of preparations illustrating "*Mechanical Injuries of the Vertebral Column*," a subject offered itself which I thought could not fail to interest my hearers.

Treated with the comprehensiveness their importance demands, these injuries, however, constitute a subject far too large to be sketched, even in outline, within the allotted hour. I shall, therefore, limit my remarks to *Fractures and Dislocations*, and even as regards these there are points which I must leave untouched.

Recognizing, as I do, that in exceptional instances of mechanical injury of the vertebral column, the clinical symptoms point to dislocation more than to fracture, as the nature of the injury; knowing also that the occurrence of dislocation, apart from fracture, as a rare fact, though doubted by some, has been abundantly verified by anatomical examination after death, my want of knowledge of differential diagnostic signs, sufficient, with small liability of error, in any particular case, to warrant the surgeon in affirming the presence of dislocation to the exclusion of fracture, has led me to side with those who view these two forms of injury broadly, as being commonly associated, and not to join those strict systematists who find for each a set of special signs, and in their writings allot to each its particular chapter. If, in the course of this lecture, I appear to insufficiently notice, or even seem to some present to ignore the work of others, I beg that my silence in this respect may not be attributed to my undervaluing its importance, still less to egotism. The remarks I offer you to-day have no claim to be regarded as, even approximately, a complete dissertation embracing a review of the literature of these injuries. I ask that you will accept them simply as a brief discussion of facts as they have come before me in the course of my daily work.

The Surgical In-patient-Registers of the Middlesex Hospital show that in a period of 24 years, ending with 1889, there were received into its wards 33 cases of fractures and dislocations of the vertebral column. In the same period there were also admitted as in-patients 5,326 cases of

fractures of other bones. A comparison of these two numbers gives, approximately, 0·935 as the percentage value of the relative frequency of these forms of injury of the vertebral column in the practice of this hospital. This ratio would represent their frequency in the district in which the Middlesex Hospital is situated to be nearly three times as great as that given by Gurlt in his valuable compendium, the "*Handbuch der Lehre von den Knochenbrüchen*." The explanation of this apparent, great discrepancy is easy. Gurlt's percentage value was deduced from an analysis of the total number of all fractures treated at the London Hospital in 20 years, viz., 22,616, of which 75 only were fractures of the vertebral column. My own very much smaller numbers comprise those fractures only which were taken into the wards, and they do not include those treated in the out-patient department of the hospital. These latter are, however, a numerous class, comprising most of the simple fractures of the upper limbs, and also many uncomplicated fractures of the ribs. The unfortunate destruction by fire of all the Out-patient-Registers of the Middlesex Hospital, a few years ago, has deprived me of the material necessary for completing a total of all the fractures treated there within my 24 years' period. Had such total been attainable, assuredly the large discrepancy between Gurlt's and my percentage value would have been much lessened; and possibly our values would have been found in very close accord, any small remaining difference being fairly attributable to differences in the prevalent kinds of employment of the labouring population occupying the two districts in which the hospitals are situated.

Of the 33 cases of fractures and dislocations of the vertebral column taken into the Middlesex Hospital, in the period mentioned, it has happened that 22 came under my own care. Of these 20 occurred in the male, and 2 only in the

female sex. The greatly preponderating liability of males is obviously due to their much greater exposure to the common causes of these accidents.

The distribution of my 22 cases, in relation to the ages of the patients, is shown in the accompanying table:—

<i>Ages.</i>		<i>Number of Cases.</i>	
15 to 20 years	3
20 „ 30 „	8
30 „ 40 „	6
40 „ 50 „	2
50 „ 60 „	1
60 „ 70 „	2
			22

The age of my youngest patient was 16 years, and that of my oldest patient 67 years. Gurlt's youngest patient was also 16 years old, whilst his eldest was 83 years. Both his and my table are in accord with the common experience of surgeons as to the extreme rarity of these injuries in infancy and childhood. Doubtless the great immunity during early life is referable to the greater flexibility and elasticity of the vertebral column, and to the less frequent exposure to violence at that age.

It will have been noticed in this table that about two-thirds of the cases happened in the second and third decades of life. This is just that which a consideration of the circumstances under which so many of these injuries are sustained would lead us to expect; for many, perhaps most of them, are occasioned by falls—often from great heights, as off scaffolds—in which, on the body striking the ground, the vertebral column is forcibly bent, and relatively few are occasioned by direct violence.

The preponderant frequency of fractures and dislocations in certain situations in the vertebral column harmonizes well with the supposition of their frequent causation by excessive

flexure; for, on mechanical principles, a rod built up of small pieces linked together in segments of greater and of less rigidity should, when subjected to a breaking strain, undergo disrapture at the junction of two such segments more readily than elsewhere. Now the situations where, by common experience, fractures and dislocations of the vertebral column are more common, are the root of the neck where this joins the trunk; and at the junction of the dorsal and lumbar segments. Their infrequency at the junction of the lumbar and sacral segments is doubtless mainly due to the larger sectional area of the bodies of the vertebræ, with commensurately greater strength in this part of the column.

Experiments made on the dead body have demonstrated that the force required to produce dislocations and fractures of the vertebræ is very great. It is probably much greater than is generally imagined. Thus, Malgaigne found that a weight of 100 lbs. was insufficient to tear asunder the cervical vertebræ; that the dorsal vertebræ bore a weight of 150 lbs., and the lumbar one of 250 to 260 lbs., without disrapture. He further noticed that when disrapture occurred the line of separation did not always pass strictly through an intervertebral disc, but often through the plane of union of this with the vertebral centrum, from the surface of which latter a thin scale of bone was not infrequently torn. This circumstance has its analogy in a common incident attending the violent tearing apart of tendons and bones. To cite but a few of several instances of this which could be adduced: when the tendo Achillis is torn from its attachment to the os calcis, a thin plate of bone is often detached from the great tuberosity of this bone; and the same, also, not infrequently occurs when the Ligamentum patellæ is torn from its tibial insertion; and, again, when the Sartorius is torn from its attachment to the ilium.

The resistance of the vertebræ to crushing force is not less remarkable. In experiments conducted by Masserer the body of the 3rd cervical vertebra withstood a vertical load until this reached 330 lbs., whilst that of the 5th lumbar first yielded under a load of 853 lbs.

After fracture, it is not unusual to find the body of the injured vertebra much reduced in bulk. In an instance of this published by Middeldorpf this diminution was considered by him to be the direct effect of the great pressure to which the vertebra had been subjected—in short he ascribed it directly to compression. Such reduced vertebra were figured by him, and they have been represented by Gurlt (who reproduced Middeldorpf's figure) and by others, and Middeldorpf's explanation of them has been widely accepted.

In certain instances this explanation may be correct, but there are, I venture to submit, others for which another explanation must be sought. Of this latter class this preparation (No. 2,031 Cat. Path. Ser., R.C.S.E.) showing greatly decreased bulk, after fracture, of the body of the second lumbar vertebra is, I suggest, an excellent example. (Fig. 1.) The greatly reduced vertical diameter of the injured centrum strikingly contrasts with the normal height of the centrum immediately above and below it, measured along the anterior face of the column. At p. 496 of the Catalogue, it is described as follows:—"The greater part of the body of the second lumbar vertebra appears to have been absorbed after being fractured, crushed, and, to a slight extent, dislocated laterally." . . . "The posterior part of the remains of the fractured vertebra projects far into the spinal canal." "The patient, a collier, was thrown several yards against the side of a mine, in an explosion of fire-damp. He was taken up insensible and severely scorched. The lower part of his back was bruised; but no sign of paralysis appeared till after four days, when he observed numbness and partial

loss of power in the lower extremities. At the end of nine months, these ceased, and he resumed his employment, but

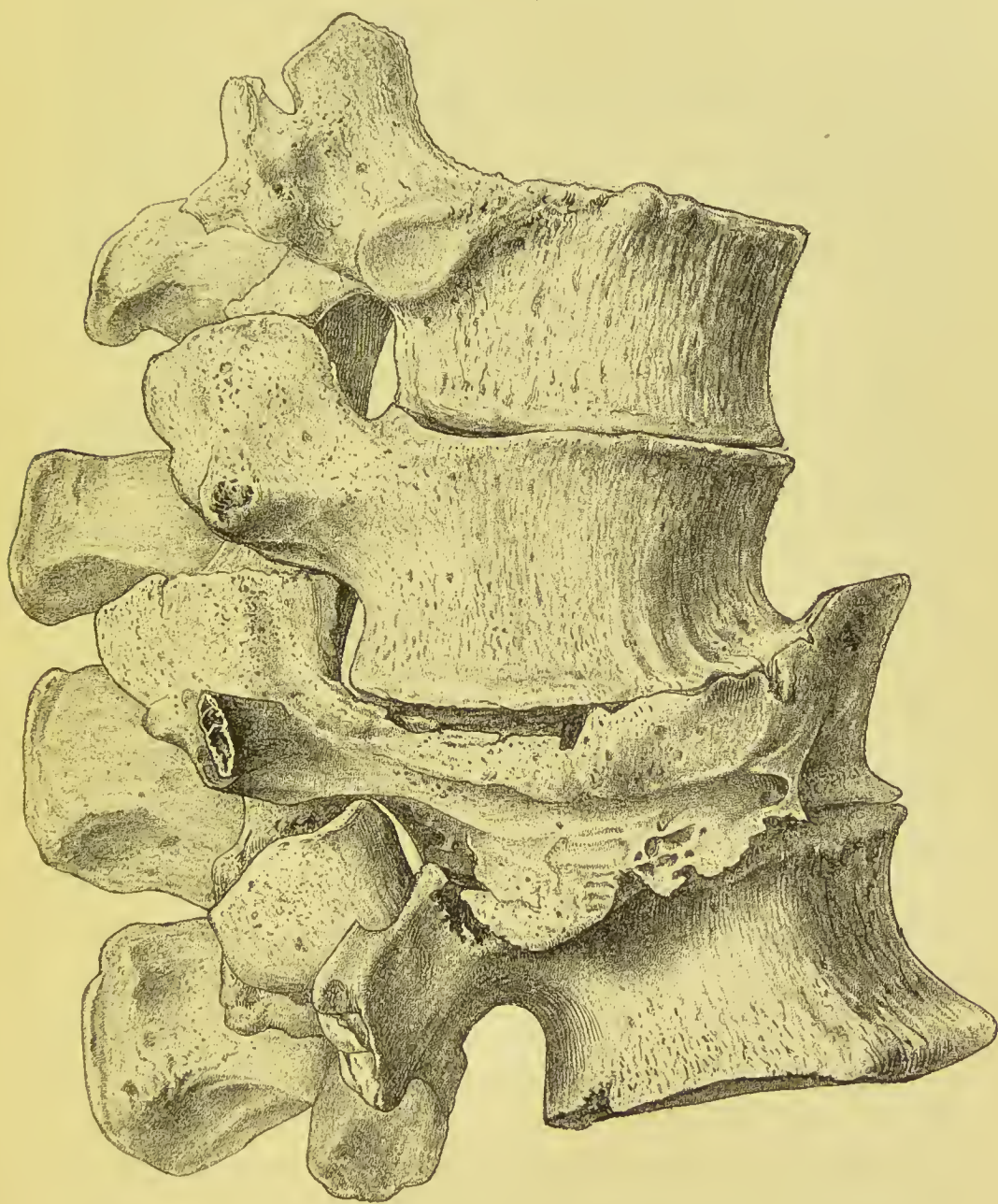


Fig. 1.—Great diminution of the 2nd lumbar vertebra after injury.

in the next week was killed by a mass of coal falling on his back."

Our Museum contains other preparations of this kind, and similar examples are to be found in most pathological collections. In such instances as these the reduction of bulk finds, I submit, its correct explanation in the hypothesis that it is a consecutive effect of the injury—it is the consequence of an atrophy, and not the immediate, direct effect of great pressure. In no instance of this sort within my own observation—I have carefully examined several—has such diminished bulk been present where death has quickly followed the injury. I have only found it where death has occurred after an interval of, at fewest, several weeks.

The suggestion that the diminution of bulk is due to trophic lesion, that it is the result of atrophy, finds an anatomical support in the richness of nerve-supply—drawn mainly from the sympathetic—distributed chiefly to the intervertebral venous sinuses, and to the cancellous tissue of the vertebra, the demonstration of which—as of so many other points in the course anatomy of the paripheral nervous system—we owe to the indefatigable Luschka. (Fig. 2.)

Bearing in mind the greatness of the force necessary for the production of fractures and dislocations of the vertebral column, it should not occasion surprise that in these severe forms of injury not infrequently more than one, occasionally, indeed, several vertebræ are implicated. Thus, in one of my cases, three, and in another four vertebræ were fractured. Such cases are also not infrequently complicated with fractures of ribs, and of other bones; and also with injuries of the thoracic and abdominal viscera. So, in one of my series, the lungs were extensively bruised posteriorly; and in each of two other cases a kidney was lacerated.

Visceral complications will almost certainly be present in gunshot injuries where the projectile traverses the patient's trunk. Thus, in the man from whose body was taken this preparation (No. 2032, Cat. Path. Ser. R.C.S.E.) (Fig. 3), show-

ing a large pistol bullet embedded in the twelfth dorsal vertebra, at the necropsy the liver was found to have been perforated and the stomach grazed. Here, death (on the day following

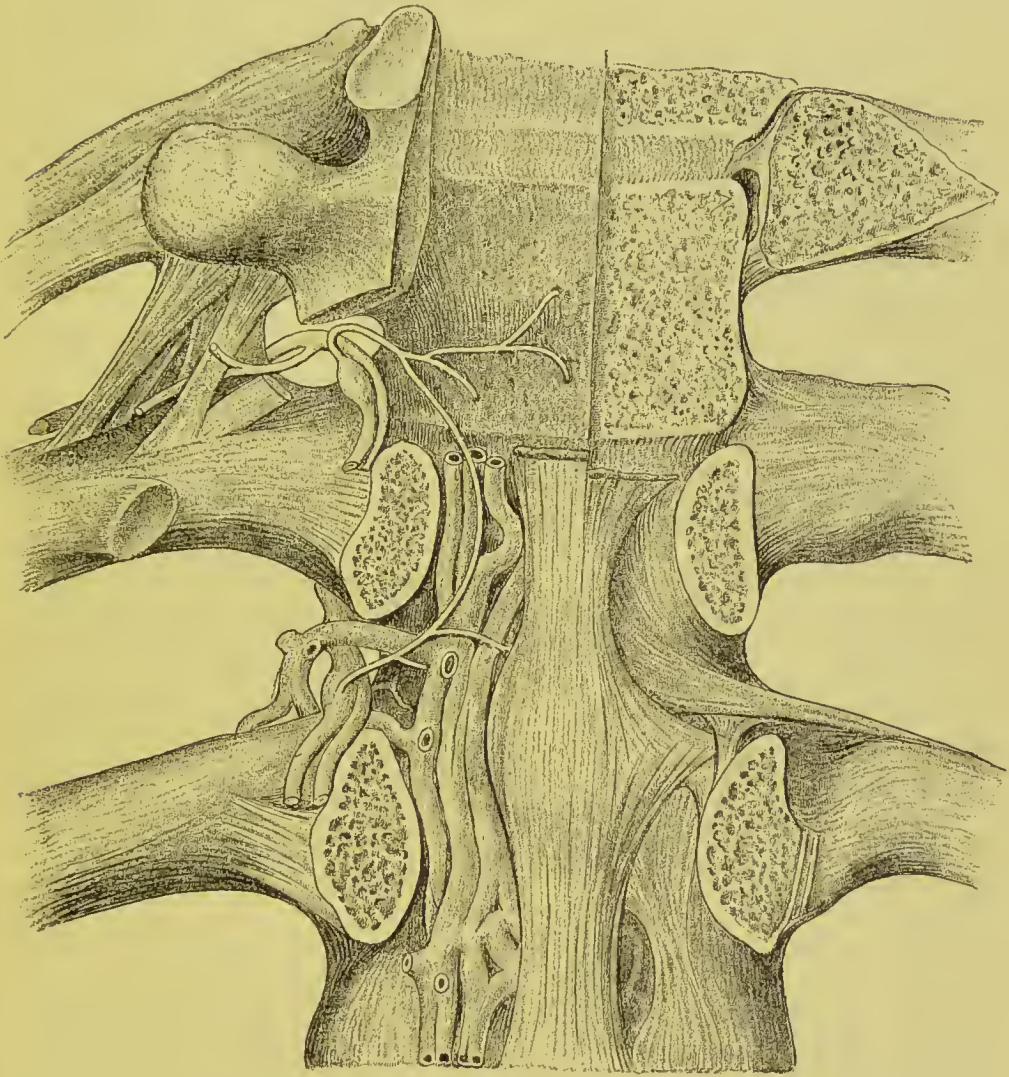


Fig. 2.—Sinu-vertebral branches from posterior division of 9th and 10th dorsal nerves distributed to venous sinuses in vertebral canal and to vertebral bodies.—(*From Luschka's Anat. Bd. L. S. 71.*)

the wound) was due to internal hæmorrhage and shock, and not to the vertebral injury, the existence of which, in the absence of special spinal symptoms, had been unsuspected during the patient's life. The bullet fired from a revolver of large calibre, at a very short distance, struck the man about three-and-a-half finger-breadths below and inwards from the

left nipple. It chipped the seventh rib, traversed the pleura without injuring the lung, passed through the diaphragm,

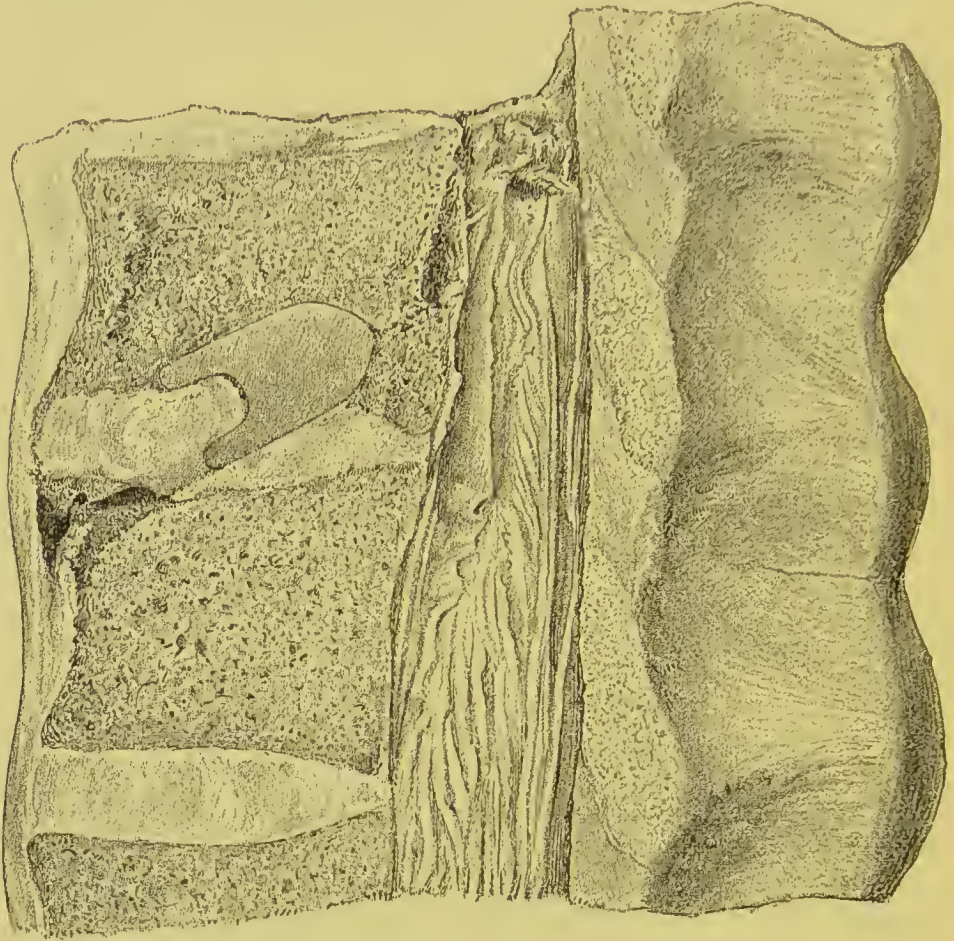


Fig. 3.—Pistol bullet lodged in 12th dorsal vertebra (No. 2032A, Cat. Path. Ser., R.C.S.E.).

grazed the lesser curvature of the stomach, grazed also the abdominal aorta, and furrowing the upper margin of the first lumbar vertebra and intervertebral disc, lodged where it may be seen in the twelfth dorsal.

I would, in passing, notice the close similarity of this preparation to that figured by Hamilton, in his classified work on "Dislocations and Fractures," taken from the body of the former U.S. President, A. Lincoln, assassinated by Wilkes Booth, a case which, at the time of its occurrence, awakened universal sympathy and interest.

Except those relatively unimportant forms of injury, where a glancing bullet breaks off a spinous process, or a transverse process, without injuring the vertebral canal and damaging its contents, gun-shot fractures of the vertebral column must be regarded as extremely grave injuries. Nearly all are almost inevitably fatal in the rough circumstances of life inseparable from a military campaign, particularly when this is carried on in wild or in half-civilised lands, where are almost unavoidably absent that assiduous, unremitting care, and skilled nursing, upon which, in most instances of survival, recovery mainly depends.

I do not remember, in the course of the Crimean Campaign, one single instance of survival of a gun-shot injury of the vertebral column.

In civil practice, however, a small number of such wounded escape with life. Thus, in one of my series, the man was in fair health, but paraplegic, $2\frac{1}{2}$ years after the date of the injury. In this case the course taken by the bullet was remarkable. Entering under the left collar-bone, it traversed the apex of the lung (demonstrated by hæmoptysis), and then, taking a circuitous route, fractured the 11th dorsal vertebra, severely damaging the spinal cord at that level.

Survival of the injury also occurred in the case illustrated by this preparation from our College Museum (No. 2,033, Cat. Path. Ser., R.C.S., Eng.), in which a round pistol-bullet is seen lying in the vertebral canal, upon the lamina of the 9th dorsal vertebra. Paraplegic, the man survived the receipt of the wound 12 years.

This preparation, to which I now invite attention (No. 112, Cat. Mus. Midx. Hosp.) (Fig. 4), illustrates a widely different result—death instantaneously followed the shot. The bullet, fired from a pocket-pistol at a very short distance, is seen lying on the posterior surface of the body of the 2nd cervical

vertebra, the odontoid process of which it has fractured, after severing the spinal cord.

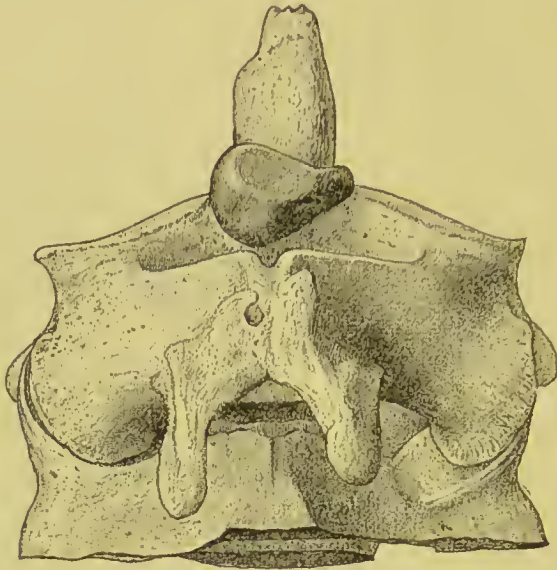


Fig. 4.—Pistol bullet lying on Odontoid process of Axis which it has fractured.

The late Mr. Alexander Shaw, a former Member of the Council of this College, and a surgeon of the Middlesex Hospital, who was acquainted with the circumstances, told me that the paramour, who, at the moment the shot was fired, was asleep with the man in bed, awoke startled by the explosion; the man, however, to her surprise, did not move, he appeared to sleep on—but he was dead.

In this theatre it would be out of place—as it is also quite unnecessary—to cite, at any length, evidence to show that fractures and dislocations of the vertebral column owe their grave significance to associated damage to the structures contained in the vertebral column, of which the foregoing case is such a terrible example; but to some of these concurrent lesions I would now devote a few minutes.

All who have made many necropsies after these injuries of the vertebral column, know how common it is to find in the vertebral canal *extravasations of blood* which have escaped from the venous sinuses within the vertebræ, and from the

venous plexuses spread over the posterior surface of the bodies of the vertebræ and upon the visceral aspect of their arches. Such hæmorrhages may extend to considerable distances from their sources; and, when copious, the effused blood may exert pressure on the spinal cord through its dural sheath. Serious as are such extra-dural hæmorrhages, graver still are those within the sheath, and yet more grave are those which occur within the spinal cord itself.

These last are not unusual; my fatal cases furnished several examples. One of these appears to me of such importance that I will read an extract relating to it, taken from the *Pathologists'* record in the P. M. Register of the Middlesex Hospital:—"The spinal cord," it says, "at the lower part of the cervical enlargement is reduced to a thin pulp of creamy consistence, pink from the admixture of extravasated blood; and, for some distance below this the grey substance of the cord appears to be replaced by blood-clot, so great is the amount of this. *In the lumbar region of the cord the proper nervous tissue seems to be almost entirely replaced by blood-clot.* The spinous process of the 6th cervical vertebra is detached by fractures through its lamina near the pedicles, and the body of the vertebra is split vertically into two halves. Upon the posterior common ligament is some extravasated blood and granulation tissue. This ligament is untorn, except in a few of its fibres; and the anterior common ligament is intact. The dural sheath contains much extravasated blood."

To this it should be added that the lumbar segment of the vertebral column did not exhibit any traces of injury.

The significant bearing of such a case on the question of operative procedure at the seat of ascertained fracture (which here was at root of neck) is evident; for, in addition to the large hæmorrhage within the spinal cord in that situation, there was also present another and very copious

hemorrhage in a remote inferior part of the spinal cord, the existence of which was unsuspected, and, I submit, could not, under the circumstances of the higher injury, have been diagnosed.

The nature of the injury sustained by the spinal cord in the above case was obviously a severe crush. This was the form of damage verified in most of my fatal cases—the cord was found crushed, pulped, its structural continuity broken, the dural sheath generally remaining untorn. Instances of less severe squeeze, such as might be conceived capable of merely suspending the functions of the cord, without or with but slight damage to its structure, so that, upon removal of the pressure, restoration of function is conceivable, are, I imagine, not common.

To the question whether there are any clinical symptoms which, taken by themselves, apart from the history of the accident, and of the order of their accession (about which frequently no trustworthy information is procurable), and also irrespective of what may be learned by closely watching the course of a case, may enable the surgeon called to one of these accidents, promptly, and with reasonable probability of correctness, to distinguish between the several kinds and degrees of damage the spinal cord may have sustained; to this question, I submit, at best a doubtful, and, more frequently, a distinctly negative answer must be given.

I cannot now pursue this matter further, but will pass on to notice briefly some clinical phenomena of interest associated with these injuries, and I will first speak of “Reflexes.”

As regards the group of phenomena included under the term “*Spinal Reflexes*,” it was, until lately, I might say (I think without incurring a charge of serious misrepresenta-

tion), universally taught in our medical schools that in severe transverse damage of the spinal cord, so often associated with fractures of the vertebræ, those reflexes of which the nervous mechanism is situated below the seat of injury are immediately suspended; that they remain in abeyance for a variable period, after which, the patient surviving, they return; and later, where the damage amounts to a complete severance of the cord, they finally disappear.

Doubt has lately been thrown on this doctrine. In a paper published in the "Transactions of the Royal Medical Society" for 1890, Dr. Bastian narrates four cases of complete transverse lesion of the spinal cord, which had occurred under his own observation, in which, from the date of distinct evidence of the lesion, the reflexes were abolished, and continued absent until the patient's death. The interval between this and the disappearance of the reflexes, in four cases adduced, varied between 19 days and 17 weeks. In two of these cases the local lesion of the spinal cord originated in disorder induced by secondary cancer of the vertebræ. In the third case the spinal lesion was deemed to be myelitis, possibly connected with a remotely distant fall; and, in the fourth, the spinal lesion was conjectured to have originated in "a vascular occlusion of some kind."

Obviously, these four cases belong to a different category to those which form the subject of this lecture; but Dr. Bastian quotes from the St. Bartholomew's Hospital Reports, Vol. XXI., and from the publication entitled "Brain," 1887-8, cases of transverse lesion of the spinal cord associated with vertebral fracture: cases, therefore, of the kind I am discussing, which appear to support his view. My own experience, as regards spinal reflexes in this class of cases, is in accord with that of Sir Wm. Savory, published in Vol. V. of the St. Bartholomew's Hospital Reports. In a not inconsiderable number of my cases, absence of reflexes was noted at the first examination of the patient made

shortly after the receipt of the injury; the reflexes reappeared after an interval of time, and they again slowly disappeared where the patient survived, paraplegic, the immediate effects of the injury, and life was prolonged. In some instances in which reflexes could no longer be excited in the lower limbs by the ordinary methods of inducing them, they continued to be provoked by the passage of a catheter, and this occasionally in a degree inconvenient to the House-Surgeon using the instrument.

Priapism I allude to merely to say that whereas this has been thought by some observers never to occur where the injury to the spinal cord is situated below the level of the sixth dorsal vertebra, I have certainly noticed it in injuries below this level, although less frequently in connection with such than with higher lesions of the cord—a semiturgescence and not complete rigidity of the organ was the rule.

A very distressing phenomenon associated with these injuries, one of not infrequent occurrence, and one which, I think, has scarcely received in text-books the notice it merits, is *vomiting*. Jacobson, however, whose excellent article on these injuries, published in the “System of Surgery,” edited by Mr. T. Holmes and myself, should be read by all, gives a good description of it. The vomiting observed in these cases is not the easy overflowing of a greatly over-distended stomach effected by slight effort, such as that occurring in an advanced stage of chronic intestinal obstruction; nor is it marked by the prolonged retching which characterises sea-sickness in its more severe forms; but in these spinal injuries the contents of the stomach are forcibly expelled by short, quick, energetic acts. Thus, in one of my cases in which four dorsal vertebræ (3rd to 6th) were fractured, and the spinal cord severely damaged, the contents of the stomach were, on one occasion, ejected to the distance of at least six feet beyond the patient’s bed. I ought, however, to add that such excessively violent vomiting as this is

exceptional. Now, in the presence of palsy of the abdominal walls such forcible vomiting certainly appears remarkable.

Probably some of us, whilst crossing the Channel, have had painful experience of the successive steps of ordinary vomiting. So far as the muscular mechanism of the process is concerned, the first act is a deep inspiration, in which, the diaphragm contracting, descends to its lowest level, or, perhaps, to express this more accurately, in which the circumferential arched muscular portion attains its greatest depression. This fixes the stomach, and it also affords a resistant surface against which the stomach may be squeezed by the abdominal walls when these, in turn, contract. This contraction is the second step, and it is the effective factor in the process, for contractions of the stomach itself appear to play a subordinate part.* Now, in complete transverse lesion of the spinal cord—say at the root of the neck, such as is often concurrent with fractures of the vertebral column in that situation—whilst the stomach preserves its nerve-supply, drawn from the vagus and sympathetic, the muscular walls of the belly are paralysed, and the diaphragm is dependent on the phrenic nerves alone, for the six lower intercostal spinal nerves, from which Luschka has traced filaments to it, are placed out of gear.

Under these altered conditions, how is vomiting, often forcible, effected?

We may gain a hint by watching the process of breathing in these injuries. Here, where the concerted action of the several parts of the nervous mechanism of breathing has been suddenly interrupted, inspection of the patient's belly discloses that the working of the diaphragm—so even and regularly rhythmic in ordinary quiet breathing, is disordered, it is irregular and laboured. In these traumatic cases, where the breathing *suddenly* takes the form termed *diaphragmatic*, this disturbed action of the diaphragm is much more obvious

* cf. Foster's "Phys."

than it is where this type of breathing has been *slowly* acquired, as in connection with paraplegia due to slowly increased pressure on, or to progressive disease of, the spinal cord.

Attention was long ago called by Sir Wm. Savory to these differences in the behaviour of the diaphragm in the two classes of cases. The inspiratory descent of the diaphragm, in cases of traumatic interruption of the spinal cord, is a jerking and not an even movement; indeed, in some instances its contraction might, without serious inaccuracy, be designated clonic. Here expiration can be effected only and wholly by the elastic recoil of the belly walls, any active and concerted contraction of these being impossible.

When, as is usual in these cases, the belly becomes tympanitically distended, the tightened abdominal walls, stretched to the utmost of their extensibility, become the resistant surface against which the stomach is squeezed and its contents ejected forcibly by the sharp, sudden, energetic (not to say spasmodic) contraction of the descending diaphragm. Here, then, we see a transposition of the rôles of the two active muscular factors in the process of vomiting—of the diaphragm, and the belly-walls.

A *phenomenally high temperature* is a noteworthy circumstance which has been observed in certain instances of lesion of the spinal cord, concurrent with vertebral fractures and dislocations. This is well-known, but I mention it here for the purpose of calling attention to it, as the subject is yet very imperfectly understood, and requires further investigation. Its occurrence has been noticed by several writers on these injuries. I have myself observed it, and this under conditions which precluded its being regarded as symptomatic of acute local inflammation. No perfectly satisfactory explanation of the phenomenon is known to me.

In transverse lesions of the spinal cord, associated with injuries of the vertebral column such as those we are

considering, the subject of *micturition* is not altogether devoid of interest, if only for one noteworthy circumstance sometimes present. I refer to discomfort, to uneasiness, felt in the lower part of the belly, which may amount to severe pain when the urinary bladder has become distended and needs relief.

As is well known, concurrently with the motor and sensory paraplegia which mark such lesions of the cord, retention of urine occurs, and, unless relieved by catheter, over-distension of the bladder ensues, followed later by dribbling off of its contents. Where the patient does not quickly succumb to his injuries, in some instances after a variable period, the urine drains away through the urethra nearly as soon as it enters the bladder, and this viscus never becomes filled. In other instances the function of the bladder tends to resume what may be termed a normal habit. Here the urine does not continuously dribble off, but when a certain quantity has collected in the bladder, and the limit of toleration of distension of this viscus is reached, its contents are expelled by reflex contraction of the extrusor. Such limit is usually reached before what may be designated the normal capacity of the bladder is attained, and it is more quickly reached in the presence of cystitis.

Uneasiness amounting, as I have known, to very severe pain in the lower part of the belly, when the distended bladder requires relief, occurring in the presence of complete anæsthesia, tactile and thermal, of the surface below the level of the spinal injury—evidencing potential discontinuity of the spinal cord—cannot be regarded otherwise than as noteworthy, for here the lesion of the spinal cord bars the customary anatomical paths along which sensory stimuli, entering the cord by the sacral spinal nerves, ascend to the brain, and the sympathetic system would appear to be the only link joining the discontinuous lower and upper parts of the spinal cord, so to be the bridge through which the sensory

stimuli are transmitted, and consciousness of the state of the bladder is evoked.

It remains for me to notice, and it can be only very briefly, the treatment of these injuries. This falls naturally under two heads. 1. Their general care and management. 2. Operative procedures.

1. The principles governing the measures comprised under the first head—general care and management—are so familiar to all, and there is such complete accord in regard to them, that it is unnecessary, and, indeed, it would be out of place to enlarge on them here; but I would state my conviction that no class of cases demands of the surgeon closer direct supervision, and in none is there greater necessity for his close personal attention to details of nursing, too frequently esteemed trivial and relegated to subordinate attendants; and this conviction is my apology for touching briefly on a few topics to which otherwise, in this theatre and before this audience, I should not refer.

In other fractures, as in the limbs, after restoration of normal figure by approximation of fragments, the endeavour is to retain these in proper position, and ensure them rest by the supply of external support, and by a suitable posture of the injured member. If similar measures are applicable to fractures of the vertebral column, how is it that they seem so often to receive so little attention? Yet fixation of a broken backbone should certainly be the endeavour of the surgeon, even although it may be but imperfectly attainable. Even in fractures in the mobile cervical segment of the spinal column, much can be done towards ensuring fixity, so important for the prevention of additional damage to the cord through movements of the outer parts. Here the adaptation of a gutta-percha shield, embracing the occiput and scapulæ, has certainly appeared to me useful, and it may be supplemented by a long partially-filled sandbag, arranged in the figure of a horseshoe, the loop of which encircles the

head and sides of the neck whilst the two ends rest on the collar-bones. In fractures in the back and loins a large shield of plaster-of-paris may be preferably used. If the precaution is taken of placing between the surface of the body and such shields a very thick, elastic layer of cotton wool, it has seemed to me that there need be little apprehension of causing pressure-sores by the use of these appliances.

All present must have had painful experience of the difficulty of preventing bed-sores, and will have observed much difference in the tendency to their formation. In some patients, notwithstanding very great care to secure distribution and equalisation of pressure, and to prevent its accumulation on particular parts, as by the use of a water-bed, or preferably, I think, a spring mattress-frame, and by shifting, at short intervals, the posture of limbs, and other measures, in spite of every precaution, bed-sores form and spread with startling rapidity. This some have considered evidence of trophic nerve-lesion. Yet in some of these instances, where the patient survives, such pressure-sores will heal apparently not very differently, as regards manners and rate of cicatrization, from bed-sores, independent of spinal lesions, a circumstance which seems unfavourable to the correctness of the above supposition. The late Prof. Hueter, of Greifswald, drew attention to the quick supervention of bed-sores upon the accession of fever, and he tried to prove a causal connection between this and decubitus, but, as it appeared to me, unsuccessfully.

The accession of *cystitis*, so often a first step on the road ending in pyelitis, and interstitial suppurative nephritis, a frequent cause of death where life has been prolonged over a few weeks from the date of the injury, is a matter of such serious concern that too much caution cannot be observed to avoid the introduction of septic substances with the catheter, since the possibility of inducing cystitis in this manner

may not be doubted. I should not refer to so obvious a subject had I not frequently witnessed in practice, under the false security of a supposed strict antisepsis, such a want of exactitude of observance of details of (chemical) cleanliness as necessarily compromised the patient. In daily bed-side work the exactitude which characterises a chemical laboratory may not always, or even usually, be attainable, but it should, none the less, ever be our aim.

Operative procedures, undertaken in the injuries we are considering, are of two kinds. One category comprises manipulations adapted to the reduction of dislocations and displacements of fragments, the other includes various cutting measures, designed for the removal of pressure conceived to be made on the spinal cord by dislocated or by displaced pieces of fractured vertebrae, either by replacing these in their normal positions, or by their complete removal.

When, in any case, the signs of dislocation are obvious on inspection, or are recognisable by touch (even though the co-existence of fracture cannot be excluded), the question of attempting reduction will require instant consideration and decision.

My own experience in this subject (as must be that of any single individual) is necessarily very limited. Only in a very few instances have the local circumstances appeared to me sufficiently clear to warrant an attempt at reduction, and only in one case did this appear to be beneficial. It need scarcely be added that every such attempt should be conducted with the greatest gentleness, and no attempt should be undertaken without a previous clear conception of the relations of the presumably dislocated parts, and of the mechanics of the displacement; it should ever be borne in mind that the risk of inflicting additional injury on the spinal cord is very real.

As regards cutting procedures for the removal of

presumably existent pressure on the spinal cord, I speak with much reserve, and with diffidence in reference to traumatic cases. In other classes of cases I have exposed and opened the sheath of the cord, and have not found the technical difficulties of the operation great.

Here, in traumatic cases, the immediate motive of the operation is the removal of pressure conceived as being exerted on the cord by a displaced vertebra, or by fragments. But in such injuries of the vertebral column, when the functions of the spinal cord are at once interrupted, when motive and sensory paraplegia are immediately present, is it possible clinically to distinguish between the interruption of function due to present compression, and that due to structural discontinuity produced by a cause acting momentarily at the time of the accident and ceasing immediately afterwards? I am not acquainted with symptoms which would enable us to differentiate these two conditions. From the evidence of many necropsies, I am disposed to think that, in not a few instances, damage to the spinal cord, and this of the most severe kind, amounting to its disruption, may be, and frequently is, inflicted by an instantaneous crush occasioned by transient displacement of vertebræ or fragments of them, at the time of the violent flexure of the spinal column which produces the fracture, immediately after which the resilience of the undamaged hard and soft structures brings back the column to its normal figure, so that at the necropsy, as I have verified, no persistent encroachment on the space of the vertebral canal is found, and this I have known even where the fracture was comminuted.

In such a case, obviously, the infliction of an external wound would be useless; and it might even add to the already great danger, although during the operation, and subsequently, the strictest attention was observed with respect to the well-known technical details for securing asepsis.

But supposing the vertebral canal to be encroached on, and the spinal cord to be actually pressed on by displaced pieces of bone, are these latter generally accessible and capable of being removed? Here again, my experience—as I have already said, necessarily limited—inclines me to a negative reply. I have more often found such encroachment on the space of the vertebral canal, entailing pressure on the cord, to be due to intruding pieces of a vertebral centrum than to fragments of a crushed-in arch; and the difficulty of removing the former intrusives would be great, and, I think, frequently insuperable. Even where practicable, and accomplished, the extraction of such fragments would, I conceive, usually little influence the result in presence of the damage, in such cases commonly irreparable, which the spinal cord may have sustained.

From my present standpoint I am disinclined to immediately interpose surgically, except where the presumed encroachment on the canal is by an in-crushed arch, and, even here, my expectation of a beneficial result would not be very sanguine.

The circumstances are different where the symptoms of disorder in the spinal cord first set in after an interval and progressively increase, suggestive of its causation by pressure, as by excessive local inflammatory exudation, or by masses of callus. It is in such circumstances as these that operative intervention *may appear* more hopeful. I say "*may appear*," because the fact of the occasional spontaneous recession of the spinal symptoms after such vertebral injuries must, in certain cases of recovery after operation, leave it uncertain how far such recovery can, without probability of error, be rightly attributable to the surgeon's work.

In conclusion, Mr. President, let me thank you, Sir, and my audience for the attentive hearing you have given to a discourse of the numerous imperfections of which the lecturer is himself deeply conscious.

APPENDIX OF CASES.

1. *Fracture of the 2nd Cervical Vertebra. Recovery.*

On 27th May, 1879, R—, æt. 66, a tailor, after dinner fell asleep, scated on the edge of the shop-board, off which he tumbled on to the ground, striking sharply the back of his neck—it was supposed against the edge of the board (really a sort of table). He was at once brought to the hospital, and admitted. There was marked tenderness over the lower cervical spinous processes, and he complained of “numbness” in both arms.—28th. Swelling and ecchymosis over the lower part of his nape. Bronchitis; his lungs are emphysematous. Temperature 103° F.—2nd June. Torticollis first noticed. Head inclined towards the right shoulder, which is raised. The tip of the 5th (6th?) cervical spinous process seems slightly unduly prominent, but this may be illusory since the swelling and induration of the soft parts covering it prevent a critical examination. The bifid spinous process of the axis projects so much backwards as to form a very obvious prominence, two fingers-breadth, below the occipital tuberosity; and its arch is so distinctly traceable that the finger-tip can be pressed into its anterior concavity. Rotation of the head in the horizontal plane does not seem limited, and (forward) motion is not abnormally restricted, but backward movements of the head in the sagittal plane are hampered and limited. The numbness at first felt in the arms disappeared, and some time later he resumed work.

Comment.—The local circumstances in this case seem to be best explained by supposing the arch of the axis to have been detached from the body by fractures through its pedicles, after which the arch, with the spinous process, was drawn upwards by the group of small sub-occipital muscles. These fractures were probably caused by direct violence, the impact of the upper part of the nape with the edge of the board. The spinal cord escaped injury, unless the numbness in the arms should be regarded as evidence of a slight and transient lesion.

2. *Dislocation of the 4th Cervical Vertebra. Paraplegia, &c.*
Death on the 3rd day.

J—K—, æt. 54, a stout heavy man, was admitted into the Middlesex Hospital under my care, in the forenoon of 28th November, 1875. On the preceding evening, after drinking several glasses of beer, he stumbled on the stairs as he was going to his room, and fell. On coming to his senses, for he was a short time unconscious, he found that he could not get up. His neighbours, supposing him merely drunk, lifted him up off the ground and placed him in his bed; and next morning, as he was not better, they brought him to the hospital. The patient mentioned that, three weeks previously, he had been knocked down by a cab, of which one shaft struck and grazed the nape of his neck, and one wheel bruised his leg. A constable then brought him to the casualty room of the hospital where his graze was dressed, after which he walked to his room in Poland Street, near to the hospital. He attended the casualty room daily during a week, when he returned to work, but from the time of the accident he continued to have much pain in the back of his neck and between the shoulders. When received into the hospital (28.11.75) he could forcibly flex the right forearm when this had been passively extended; and he could also adduct the limb when it had been passively abducted. With the above exceptions all power of voluntary movement was lost in the lower and also in the upper limbs. Reflexes were absent from all these members, and from the trunk. With the exception of a small sensitive area under the right collar-bone there was anæsthesia of the whole surface of both lower limbs and of the trunk, the limit being about two inches above the right and higher above the left nipple. There was also anæsthesia of the left upper limb, and of the right, with a doubtful exception of a small slightly sensitive area at the upper and inner side of the upper arm. Breathing was mainly diaphragmatic, very laboured, the Scaleni co-operating, the nostrils dilating widely. The nape was so swollen that the spinous processes of the vertebræ could not be felt. He complained of great pain and of much tenderness here. He had retention of urine. He had also vomited.—29th. Face bluish; and hiccough. He cannot now adduct the right arm and the power of flexing

the forearm is nearly lost.—30th. Death at 1 o'clock a.m. from slow suffocation.

Extract from P. M. Reg., No. 279, 1875.—"Much blood was found extravasated in and between the muscles of the nape, and also amongst the pre-vertebral structures, particularly opposite the 4th and 5th vertebræ, where was a mass of recent clot. Laterally, the extravasated blood had spread over and beyond the transverse processes, between the 4th and 5th pairs of spinal nerves. On the left side the vagus was surrounded by blood-clot. The Rectus capitis anticus major was lacerated. No trace of the fibrous tissue of the anterior common vertebral ligament was recognisable on the front of the bodies of the 4th and 5th vertebræ, where it seemed to be replaced by a soft red mass of granulation-tissue. The 4th cervical vertebra was partially dislocated, its left inferior articular process being so displaced as to leave almost completely uncovered the articular facet of the corresponding superior process of the 5th vertebra, the capsule of this joint having been torn. The exposed cartilages were reddish. The right capsular ligament was slightly lacerated, and the Ligamentum subflavum connecting the laminae of the 4th and 5th vertebræ was partially torn through. The inter and supra-spinous ligament were uninjured. No blood was found within the vertebral canal, nor within the dural sheath. The spinal cord was greatly compressed. It was removed for hardening and further minute examination by the pathologist, whose notes of this, unfortunately, are missing from the Register. Beyond excessive pulmonary congestion all the viscera of chest and abdomen appeared normal. Here the question arises whether the injury which caused the patient's death was exclusively the result of the fall he had on the night of 27th November, when drunk. The nature of the substance laying on the front of the two vertebræ—mingled blood and 'granulation-tissue'—and the apparent disintegration of the anterior common ligament, together with the persistence of pain in the neck from the date of the blow by a cab-shaft (three weeks before his final fall), favours the supposition of an earlier damage of the column, followed by inflammation and by weakening of the column, which brought it into a condition favourable for the cause both of the dislocation and large extravasation of blood by violent flexure sustained in the fall. The great

swelling of the nape masked the local signs of dislocation. Had this been recognised, reposition ought to have been attempted, and, manipulation failing, operative measures, would have required consideration. In presence of the very grave and extensive damage of the surrounding soft parts, already presumably inflamed, any operation would have been performed under most disadvantageous circumstances. The supervention of suppuration must be regarded as highly probable, and the result, it is thought, would hardly have been other than that which happened."

3. *Fracture of the 6th Cervical Vertebra. Motor and Sensory Paraplegia. Injury of the Spinal Cord in the Cervical and Lumbar Regions. Death on the 8th day.*

R. A. C.—, æt. 29, a painter, fell off the roof of a house and injured his back. $1\frac{1}{2}$ hours afterwards he was admitted into the Middlesex Hospital, at 9 a.m., 29th April, 1879. He complained of pain at the "top of his back," but no irregularity of the vertebral spinous processes or other local sign of damage was discoverable there or elsewhere in the course of the vertebral column. He had complete motor and sensory paraplegia of the lower limbs, and of the trunk as high as a line drawn through the nipples. Reflexes were absent. He could move his arms slightly, but their movements were irregular and unsteady. Breathing, diaphragmatic. Twelve hours later (at 9 p.m.) motor palsy of arms was complete, tactile sensibility of their surface continuing. Retention of urine.—30th. Action of diaphragm jerky. Colour of face slightly dusky. Pulse rapid, small. Temperature, 104° F. Mouth and throat dry. Articulation difficult; speech indistinct. Complete tactile anæsthesia of both arms. Obstinate vomiting in course of night.—1st May. Belly very tympanitic. Slight reflex movements of toes, flexion of right ankle, and of left ankle in less degree, excitable by pressure of nib of quill-pen on soles.—3rd. Pressure sores forming on buttocks, and also a few blebs on thighs in parts not exposed to pressure. Tongue very dry and wrinkled.—5th. Complains of "feeling a lump in the belly," and also of a sharp pain shooting from the nape through the ears. Temperature 104° F.—6th. Cystitis. Delirium.—7th. Death at 1 a.m.

Extract from P. M. Reg., 1879, No. 102.—"At the lower part of the nape the muscles at each side of the vertebral column are torn, and blood is extravasated amongst them. Much blood is effused in the vertebral canal. The spinous process of the 6th cervical vertebra is detached by a fracture through the lamina, near the pedicles; and the body of the vertebra is split vertically into two halves. Upon the posterior surface of the vertebral centrum, about the fracture, are some blood-clot and granulation tissue. The anterior common ligament is intact, and the posterior common ligament is not torn, excepting in a few of its fibres. There is not any present displacement. The dorsal sheath contains much extravasated blood. The spinal cord at the lower part of its cervical enlargement is reduced to a thin pulp of creamy consistence, pink from admixture of extravasated blood, and for some distance below this the grey substance appears to be replaced by blood-clot, so large is the quantity of this. In the lumbar region of the cord the proper tissues seem to be almost entirely replaced by blood-clot. Blood is extravasated under the occipital pericranium. Intense congestion of internal viscera. Over the upper part of the sacrum is a bed-sore of the size of the palm. To this it should be added that no trace of injury was discoverable in the lumbar segment of the vertebral column, and that the part of the spinal cord intermediate between the cervical and the lumbar enlargement was free from all appearance of damage."

Some points worthy of notice in this case are (*clinical*):—

1. The progressive extension of the paralysis, including the extension of sensibility in the upper limbs within a few hours of the receipt of the injury, referable to continuing hæmorrhage in the spinal cord breaking down its tissues;
2. The behaviour of the spinal reflexes;
3. Vomiting;
4. The rapid formation of the bed-sore;
- (*path-anat.*) 5. The hæmorrhage in the lumbar enlargement widely removed from that in the cervical enlargement;
6. The severity and extent of these lesions;
7. The absence of persistent encroachment on the space of the vertebral canal at the seat of fracture by continuing bone-displacement, showing that the initial damage to the spinal cord was the work of a momentarily acting cause; and
8. The vertical direction of the fracture through the vertebral centrum, a shearing explain-

able on the supposition of an unequal incidence of the breaking force on the two lateral moieties of the centrum.

4. *Fracture of the 6th Cervical Vertebra; Paraplegia, etc. Death on the 11th day.*

Wm. B—, æt 29 years, a big, burly drayman, was brought to the hospital on 14th June, 1879, shortly after having pitched off his dray into the road by a collision. When taken into the ward all sensibility was lost in the lower limbs and in the trunk as high as the level of the junction of the 3rd costal cartilage and sternum. Below this level there is complete motor palsy of trunk muscles and lower limbs; but when the soles, particularly their inner border and the hallux, are touched with the nib of a quill-pen, flexions of the toes are induced. Breathing is mainly diaphragmatic, but the upper ribs are raised by the Scaleni, the breadth of the intercostal spaces below the 3rd remaining unaltered. The fingers are half-flexed, and he cannot extend them. He says he feels a peculiar tingling in them. He has pain between his shoulder-blades, and a sensation as of a cord drawn tightly round the upper part of the chest. Feet and hands cold. Priapism. Retention. Temperature, 98·2° F.; pulse, 72, full.—15th. Belly tympanitic. Temperature, 101° F.; respiration, 28.—16th. Power of moving the upper limbs is limited now to flexion and extension of the left forearm; to flexion of the right forearm when this has been passively extended; and to feeble contraction of the Deltoid in attempting to abduct arm from trunk. Sensibility of upper limbs not obviously lessened or disordered. Plantar reflexes lost. Priapism gone. Bullæ on both feet. Great thirst. Cystitis.—17th. Pains in both forearms. Priapism. Tongue dry, furred. Temperature 102° F. in armpit; 102·4° F. in groin. Pressure sores forming on heels.—18th. Motor palsy complete in both upper limbs, and anæsthesia is present in the area of distribution of the cutaneous branches of the ulnar nerves. Late in the same day the entire hands had become anæsthetic, slight tactile sensitiveness continuing in the forearms and arms. Cystitis increased. Temperature, 102° F.; pulse, 100; respiration, 40. Vomiting

after drinking. Priapism gone. Lips and mouth very dry. Articulation indistinct.—20th. Diarrhœa, the motions passing into his bed without his being conscious of the occurrence.—23rd. Mind wandering; he scarcely notices what is happening around him, but he answers pertinently when spoken to.—26th. Death.

Extract from P. M. Reg., No. 128, 1879.—"The free extremity of the spinous process of the 6th cervical vertebra is separated from that of the 7th vertebra by an interval of nearly 1 inch, which is made possible by a fracture through the body of the 6th, about $\frac{1}{4}$ inch above its inferior surface. The displacement of the surfaces of the fractured parts is slight, occasioning only a little irregularity of the anterior surface of the vertebral canal. The anterior and the posterior common ligament are partially torn opposite the fracture, and the anterior is thickened as if by inflammatory exudation. There is blood effused in the vertebral canal, outside the dorsal sheath, in the lower part of the neck. The part of the spinal cord corresponding to the fracture is where it gives off the 6th pair of nerves. Here, and through a considerable space, the cord is reduced to a soft reddish pulp of the consistence of cream. It is quite diffuent, and the distinction between grey and white tissue is lost. This alteration extends downwards to opposite the 2nd dorsal vertebra, below which the cord has a normal consistence, but an unusually pale, bloodless appearance. The surface of the right kidney, its lower end, in an area of the size of a florin, is raised and dotted with small elevations, the light whitish colour of which contrasted strongly with the dark congested parts around. From these whitish, elevated dots, whitish streaks and blotches are traceable through the cortex and pyramid. In one blotch is a small abscess. The pelvis of this kidney contains brownish turbid urine. Its lining is congested and ecchymosed. The left kidney shows similar morbid appearances. The bladder is capacious; its walls are readily torn. Its mucous is intensely congested, and it is blotched with extensive hæmorrhages."

Comment.—Here, where complete mechanical transverse lesion of the spinal cord at the moment of the accident may fairly be inferred to have occurred from the immediate presence of motor and sensory paraplegia, it is worthy of note that

simultaneously with these lesions the spinal reflexes were not completely abolished. The extension of the palsies to the upper limbs, referable to creeping hæmorrhage in the spinal cord: the implication of the extensors before the flexors; the continuance of sensibility after voluntary motor power was quite lost; the extinction of sensibility from the periphery centrad; the earlier implication of the ulnar nerves, are other matters deserving notice.

5. *Dislocation of the 7th Cervical Vertebra, with severe damage to the Spinal Cord. Death 8 months afterwards.*

At 2 o'clock a.m., 17th April, 1881, E. G—, æt. 38, was brought to the hospital in an ambulance, having, it was said, 10 minutes previously, been knocked down in a neighbouring street by a cab, the shaft of which, he said, struck his back. He was in a state of considerable shock, his pulse, in particular, being remarkably slow (48 beats a minute), it was also small and weak. There was great tenderness over the lower dorsal spinous processes, it was so great as to prevent a critical examination of them, but it was thought that there was a slight interruption of the regularity of their succession, due to the depression of one of the lowest. Sensibility of surface was not obviously impaired, and he could draw up and stretch out his legs. At 9 o'clock a.m., temperature 101·4° F.; at 2 p.m., 102° F.; and at 9 p.m., 100·2° F. On the 18th he lies with his head turned towards the left, and he says that he cannot lift it off the pillow. The right pupil is smaller than the left. The left angle of the mouth is slightly lower than the right. He can lift his right arm but the grasp of its hand is feeble. There is motor palsy of the left forearm and of both lower limbs, and also loss of reflexes; and their surface, as also that of the body to the level of the 9th rib, is completely anæsthetic. Priapism. His breathing is diaphragmatic, the chest walls remaining motionless excepting its lower circumference corresponding to the muscular attachment of the diaphragm, which in its contraction pulls on it. At 10 o'clock a.m. the upper limit of complete tactile and thermal insensibility was 2 inches above the level of the navel, by 2 o'clock p.m. it had ascended to

3 inches above the nipples. The left upper limb was devoid of sensibility as high as its junction with the trunk, and the right forearm is insensible up to the bend of the elbow. He could still grasp, though feebly, with the right hand. Retention has existed from the time of the accident.—20th. The upper limit of anæsthesia has descended to $2\frac{1}{2}$ inches above the level of the navel on the right, and to 1 inch lower on the left side. He still retains slight power of voluntary movement of the right arm; but there is complete motor palsy of the left upper limb and incomplete anæsthesia.—22nd. On the right side the limit of anæsthesia is 2 inches above the navel, and on the left it is on the level of the navel. He complains of a severe pain in both arms which he likens to their being screwed in a vice. A sacral bed-sore is forming. Diarrhœa.—In the early part of the following month (May) he had increased respiratory difficulty, and associated with this fever.—On May 13th the limits of anæsthesia were as stated in the last note, but an isolated band of imperfect insensitiveness, roughly corresponding to the 7th rib, was discovered. Slight reflex movements of the toes and feet occur when the soles are pricked with the nib of a quill-pen. The left forearm is completely devoid of sensibility.—22nd. Some degree of sensibility has returned in the left forearm and hand. Reflexes in both lower limbs stronger.—10th June. The sacral bed-sore is healed.—12th. 2 o'clock a.m., temperature $99\cdot8^{\circ}$ F.; at 9 a.m., temperature $99\cdot6^{\circ}$ F.; at 2 p.m., temperature $100\cdot3^{\circ}$ F.; at 9 p.m., temperature $105\cdot0^{\circ}$ F. 13th. At 2 a.m., temperature $103\cdot2^{\circ}$ F.; at 9 a.m., temperature 100° F.; at 2 p.m., temperature $100\cdot4^{\circ}$ F.; and at 9 p.m., 100° . No cause for this remarkable elevation of temperature was discovered.—20th. He can now slightly move his left arm. Reflexes in both lower limbs exaggerated. Bed-sores have again formed. Cystitis has long been present.—4th July. The mere exposure of the lower limbs by removing the bed-clothes induces clonic movements in the legs and thighs. During the remainder of this month and through August his condition progressively deteriorated.—28th September. The upper limits of anæsthesia of the surface is on the right side in the level of the junction of the 3rd rib and sternum; and on the left side it is midway between the free end of the xiphoid cartilage and navel. He moves the left

hand better but its sensitiveness is still much impaired.—10th October. Emaciated and weaker. His legs and thighs are flexed, contracted. Limit of insensibility of trunk on the right side now corresponds to the 2nd costal cartilage, and up the left to the 6th costal cartilage. The right hand is insensible in the distribution of the ulnar nerve. In the left hand only the thumb and index finger retain sensibility; the rest of this hand, the entire forearm, and the arm to the shoulder, are devoid of feeling. In the lower limbs the reflexes continue exaggerated. He lingered till 18th December, his end being hastened by an attack of bronchitis and by the formation of large pressure sores on his hips.

At the necropsy the 7th cervical was found displaced forwards on the first dorsal vertebra, and the cord was squeezed by the salient angle of the upper and posterior surfaces of this latter. The intervertebral disc torn through.

Other morbid appearances recorded were those of recent bronchitis and pulmonary emphysema, and of old pulmonary tuberculosis; of extensive arterial atheroma, and of aortic valvular incompetence; of amyloid swelling of spleen and liver, and of cystitis, pyelitis, and interstitial nephritis.

(It is greatly to be regretted that the injured part of the vertebral column and the spinal cord, which were removed for more careful examination, could not later be found, nor could the pathologist give any description of these parts other than the above.)

In this case the man's account of the accident and the extreme tenderness in the lower dorsal region of the vertebral column when he shortly afterwards was received into the hospital seemed to point unmistakably to this part as the seat of the blow, and as neither motor or sensory palsy was present, the gravity of the injury was insufficiently appreciated. A few hours later, when palsy supervened and the anæsthesia, etc., gradually ascended from the lower limbs upon the trunk, this was referred to hæmorrhage in the cord ascending from the lower end, which, on the whole, appeared the most probable hypothesis although there were circumstances which it failed to explain. The immediate absence of spinal reflexes, and later their return and exaggeration, should be noticed.

6. *Fracture (?) , with Displacement, of a Vertebra at the Root of the Neck, Paraplegia, &c. Death on the 27th day.*

J. W—., æt. 69, a basket-maker, was admitted into the Middlesex Hospital on 11th April, 1875, having, at 8 p.m., fallen headlong downstairs and severely injured his back. He said that on regaining consciousness, which he appeared to have lost for a short time, he found he could not get up, having lost all power in his legs. He was at the time in drink. The house-surgeon found him to have nearly complete motor palsy of both lower limbs, with greatly blunted sensibility of their surface, and loss of reflexes. Breathing diaphragmatic. At my mid-day visit he was lying on his back with both arms abducted to the level of the shoulders. His forearms were flexed and pronated, and when passively extended they resumed their flexed posture. The fingers were half flexed, and he could neither increase their flexion, nor could he extend them. He had a tingling sensation in the hands and in the feet. Retention.—12th. Paraplegia is now complete. Plantar reflexes, yesterday absent, are now excitable. There is tenderness at bottom of nape, where a spinous process seems unduly prominent, but the swollen state of the soft parts makes it uncertain which it is, the 6th or 7th. Power of moving his arms is improved. He can now raise his right arm to his head, and adduct it to his side, but its movements are unsteady. He can grasp a pamphlet between the thumb and the forefinger, but concurrently with this act the other fingers are flexed on the palm, and he cannot extend them. He can flex, but not extend, the forearm. In the left upper limb improvement is less marked. Sensibility of the surface of the lower limbs is nearly lost, and that of the trunk, including the lower part of the chest, is much impaired. The upper intercostals act, the lower are paralysed. Urine turbid with lithates.—13th. Some amount of “general sensibility” continues in the lower limbs, contact of a point is felt vaguely, but not localized; the degree of anæsthesia is not uniform for the whole surface, but there are areas of greater and of less bluntness. Motor palsies unaltered.—15th. Sensibility of lower limbs seems improved, and this more in the right than in the left; in some areas the gentle stroke of a feather is perceived as a light contact.—16th. Feet

rigidly extended, and on both are circular patches like erythema.—20th. A large bulla in the sole, and a slough on the heel of the right foot. Bullæ are also present along each side of the line of spinous processes in the mid-dorsal region, and over the angles of the scapulæ.—30th. The legs, which for several days have been distinctly œdematous, are now less so. Their integument is dry and brawny. No reflexes are excitable in the lower limbs by ordinary stimulus, but the passage of the catheter provokes slight adduction of the thighs.—7th May. Death.

Comment.—From the incompleteness of the motor and sensory paraplegia it is manifest that the lesion of the spinal cord in this patient was less than a complete discontinuity. Here, simultaneously with the occurrences of the lesion, “reflexes” were suspended, but they returned early. The manner in which groups of muscles were successively palsied in the upper limbs, the curiously irregular patch-distribution of the anæsthesia in the lower limbs, and the more than usual tendency to the formation of bullæ, seem worthy of notice. (The loss of the Surgical Registrar’s notes, and the absence of those of the Pathologist from the P. M. Register for 1879, which last might have thrown some light on these circumstances, are greatly to be regretted.)

7. *Fracture of three Dorsal Vertebrae and Dislocation. An Intervertebral Disc detached and extruded into the Vertebral Canal. The Spinal Cord split.*

On 21st June, 1873, at 6.45 p.m., J. C—, æt. 35, a brass-finisher, was admitted into the Middlesex Hospital under my care, having a very short time previously fallen off the roof of an omnibus in a neighbouring street. He was quite unconscious. He had a lacerated scalp-wound over the left parietal bone, and a bruise on the right forehead. His breathing was difficult. His muscles were flaccid, and no reflexes could be excited in the lower limbs. At 7.45 p.m. the conjunctivæ were found slightly sensitive. Temperature, 97.4° F.; pulse, 104. He moves his arms and he groans much; he opens his eyes when spoken to, but he does not answer.—11 p.m. He has spoken distinctly, and correctly replied to inquiries, giving his name

and address.—22nd. At the morning visit he was found to be perfectly conscious, and he complained of pain in his back. Paraplegia not quite complete in the right lower limb. 9.30 p.m. Temperature, $99\cdot8^{\circ}$ F.; pulse, 104.—23rd. Morning visit. Great pain between the shoulder-blades. The spinous process of the 4th or 5th dorsal vertebra—the swelling of the soft parts about them leaves it ambiguous which of these two—is thought to be unduly prominent. Priapism. Absolute motor paraplegia, and anæsthesia of both lower limbs and of the trunk as high as the nipples.—25th. Feeble reflexes can now be excited in both lower limbs. The limit of anæsthesia seems slightly lower than yesterday, being now a little distance below the nipples.—27th. Still great back-ache.—30th. A bed-sore has formed over the sacrum. Head-ache. Limit of insensibility seems to have slightly ascended. Urine dribbles away. (Retention had been present, and the catheter used from the first).—7th July. Diarrhœa, the stools passing away from him without his consciousness of the occurrence.—8th. Blebs on the left hip, and also over the lower ribs on this side, on to which he had been turned for a short time in order to relieve his back. Diarrhœa.—25th. The sacral sore has spread widely, and a livid blush is present on the outer side of the left leg. In the early part of August some improvement in his general condition was observed. His appetite was good, and he appeared stronger. The sacral bed-sore ceased to enlarge, and began to granulate and cicatrize; and a slough which had formed between the shoulder-blades was loosening.—Aug. 22nd. Motor paraplegia unaltered. Upper limit of anæsthesia is on level of tip of the ensiform cartilage.—24th. At 9 p.m. Temperature, $101\cdot8^{\circ}$ F. In the night a rigor.—25th. At 9 a.m. Temperature, $103\cdot8^{\circ}$ F.; pulse, 141.—9 p.m. Temperature, $103\cdot6^{\circ}$; pulse, 124. Urine very scanty.—29th. Another rigor. Temperature, $104\cdot2^{\circ}$ F.—30th. Sinking.—1st Sept. Death.

The following Extract from the "Pathologist's" record in the P. M. Reg., Vol. II, No. 172, describes the pathological appearances found at the necropsy:—

"The spinous processes of the 7th, 8th, and 9th dorsal vertebræ are broken off. The fibro-cartilaginous disc between the 8th and 9th vertebræ is completely detached from both

these vertebræ, and is lying in the vertebral canal, within which, on the left side, there is also a detached fragment of bone 1 inch long by $1\frac{1}{2}$ inches wide and thick. The body of the 8th vertebra is displaced forwards to the extent of nearly 1 inch and it is also rotated downwards and towards the right. The anterior common ligament is untorn. The spinal cord at the seat of fracture is completely disintegrated, nothing remaining here but the empty sheath. For a couple of inches above and also below the level of the fractured body the cord is softened, and it is longitudinally split. Much extravasated blood is present in the neighbourhood of the broken spinous processes, infiltrated amongst the surrounding muscles. The urinary bladder, ureters, and kidneys present the characteristic signs of intense long-continued inflammation. The lungs are emphysematous, and posteriorly congested. The liver is large, congested, soft; and under its capsule are many small hæmorrhages. The abdominal cavity shows the marks of a recent diffuse peritonitis. The interscapular pressure-sore, 6 inches by 2 inches in area, exposes the spinous processes of six vertebræ. Another sore lays bare 2 inches of the right 9th rib. A third upon the left 9th rib is superficial. The sacral sore, $4\frac{1}{2}$ inches by $3\frac{1}{2}$ inches, exposes the underlying bone. Lastly, there is a fifth pressure-sore behind the right ankle."

Comment.—When admitted into the hospital, the patient had concussion of brain, which marked the full extent of the spinal injuries. The magnitude of these is very remarkable. The complete detachment of the intervertebral disc and its extension into the vertebral canal testify to the violence of the flexure of the column at the moment of injury. In the longitudinal splitting of the spinal cord by an intruding fragment of a vertebral body, this case finds its parallel in prep., Cat. No. 2,030, Mus. Roy. Coll. Surg. The pathological appearances in the abdomen and chest point to septicæmia as the cause of death; and it appears probable that this had its origin in the extensive pressure-sores.

8. *Fractures of the 3rd and 6th Dorsal Vertebrae. Severe Transverse Lesion of the Spinal Cord. Death on the 12th day.*

T. E.—, æt. 26, a labourer, on 23rd July, 1879, fell down a shaft, roughly judged to be 40 feet deep, and sustained very severe injuries. Within three-quarters of an hour after the accident he was received into the Middlesex Hospital.

He was in a condition of very great shock, but quite conscious, and understanding and rightly answering questions put to him. He was found to have complete motor and sensory paraplegia of limbs and of trunk muscles below a line drawn through the junction of the 3rd rib with the sternum. Respiration was almost exclusively diaphragmatic, the muscles acting on the upper opening of the thorax slightly co-operating. The diaphragm contracted with short quick jerks. Tickling the soles provoked slight reflex movements of the toes. Priapism. Retention. By evening belly had become tympanitically swollen.—24th. Tympanites increased. Slight cyanosis. Tongue furred. Temperature 100° F.; pulse 130, very compressible; respiration, 36.—25th. Very forcible vomiting, the ejecta being on one occasion projected to a distance of at least 6 feet from his bed. There is a small black spot over the sacrum, and another between the shoulder-blades.—26th. Loud coarse bronchial râles. Temperature, 102° F.—28th. Temperature, 103° F.; pulse, 108, intermittent. Arms cold. Mind wandering. He seemed rapidly sinking, but he lingered until 4th August.

Extract from P. M. Reg., No. 147, 1879.—"The body of the 4th and that of the 5th dorsal vertebrae are split obliquely, the fracture passes downwards from right to left, with much sliding displacement of its surfaces. The processus trans. of the 4th, 5th, and 6th dorsal vertebrae on both sides are fractured, the right 4th and the left 5th being least separated. The processus spin. of the 3rd dorsal vertebra is completely detached from its arch. The spinal cord is almost completely severed at the seat of fracture of the vertebral bodies, the two portions being connected only by slender strands of nerve-tissue. On the outer surface of the dorsal sheath, behind, between it and the vertebral arches, is a blood-clot. The spinal cord above the injury appears considerably injected. Over the right

scapula and sacrum are superficial pressure-sores. On the heart's surface are patches of recent lymph. Each pleural sac contains O.ss. of bloody serum. The visceral pleura is coated with fresh lymph. The lungs are congested and œdematous, and the bronchi are full of frothy mucus.

Comment.—Considering the extent and the severity of the injuries of the vertebral column and of the spinal cord, it is remarkable that the patient survived 12 days. Whether the pleurisy and pericarditis should be attributed to septic infection proceeding from the pressure-sores, or referred to injury of the thoracic viscera sustained at the time of the accident, cannot be certainly determined. That the spinal reflexes in the paraplegic members were not completely suspended from the moment of the injury of the spinal cord is worthy of notice.

9. *Fracture of 5th Dorsal Vertebra, with Severe Injury of Spinal Cord. Recovery (incomplete at the time of the Patient leaving the Hospital).*

Wm. M—, æt. 21 years, a tin-plate worker, was received into the Middlesex Hospital on 23rd February, 1873, having a short time before fallen off the roof of a house. He was in a state of great shock. Occupying the interscapular region, and below this to the level of the 8th dorsal spinous process, was a puffy, tender swelling, which hid the underlying bony prominences. He had motor palsy of both lower limbs, complete in the right, and nearly complete in the left limb. "Reflexes" absent from the right, but slight reflexes were induced in the left by tickling the sole. Sensibility not obviously impaired. Breathing diaphragmatic, assisted by the upper intercostals. Retention. —24th. No obvious change in his condition.—25th. Tympanites of belly.—26th. Urine dribbling, though the catheter has been regularly used. Muttering delirium. Temperature, 98° F.; pulse 80.—27th. Girdling pain round chest. Cystitis. Tympanites increased.—2nd March. A "burning pain in the right foot."—6th. Slight increase of power of movement in left lower limb.—11th. Indication of restoration of motor power noticed in the right lower limb.—15th. Erysipelas of face. It began in lip, and disappeared in about one week.—21st. Motor palsy of right limb is distinctly less.—25th. The swelling having disappeared, the end of the spinous process of the 5th dorsal vertebra is

found to be displaced, projecting unduly backwards.—3rd April. Power of moving right leg greatly improved. Cystitis gone. He eats heartily, and sleeps well.—13th. Desquamation of cuticle of lower limbs, particularly below knees. He moves the left easily, and the right leg with a semblance of stiffness.—17th. Returns home, walking fairly. His back is supported by a plaster-of-Paris jacket.

Comment.—The incompleteness of the motor palsy of the lower limbs, together with its unequal incidence on the right and left limb, and the integrity or but slight impairment of the paretic members, combine to show that here the injury of the cord did not amount to a complete break of its continuity, but was much less than this. Here the suspension of “reflexes” in the right limb, in which the motor palsy was complete, deserves notice.

10. *Dislocation of 3rd Dorsal Vertebrae, Paraplegia, &c. Death on the 237th day.*

In the night of 6th July, 1889, E—H—, æt. 37, a watchman, who had been drinking heavily, slipped whilst crossing a plank and fell into the area of a house. He could not rise, and later when found he was brought at midnight to the Middlesex Hospital. He was then still intoxicated, but in answer to enquiries he said that he had pain “in the middle of the back,” and that his legs “felt dead.” He was found to have complete motor palsy of both lower limbs, and their surface, as also that of the trunk as high as the 9th intercostal space, had completely lost its sensibility. The end of the spinous process of the 8th dorsal vertebra seemed to be in a slightly deeper plane to those of the neighbouring vertebrae, but swelling of the soft parts left this rather uncertain. The upper ribs, above the 9th, moved in respiration, not the lower. His urinary bladder was distended, he had retention, and also priapism.—7th. Condition not obviously changed, but plantar reflexes, previously absent, are now present.—8th. Cystitis.—10th. Blebs on legs.—12th. Blebs on scutes and over sacrum. Upper limit of anæsthesia is now four finger-breadths below navel. Prepuce very œdematous.—19th August. Plantar reflexes no longer excitable, but slight reflexes

in the thighs can be induced, and twitchings of the legs occur, and this apparently independently of the application of any external mechanical stimulus. Several pressure-sores on both lower limbs. Prepuce sloughing.—27th. Temperature 103·4° F. It fell after taking of antipyrin 31. During September no obvious alteration was recorded. The cystitis persisted. The catheter had been systematically used from the time of the accident, the urine now dribbled in the intervals between using the instrument, but some urine was always found in the bladder. Although a flexible red-rubber and soft catheter was employed, its passage always occasioned pain, sometimes so excessive as to greatly distress him. The sacral sores now showed a disposition to heal.—2nd October. Reflexes, before absent, superficial and deep, very marked, are now excitable in both limbs.—14th October. Slight but distinct power of moving the left foot and toes is regained. The upper limit of anæsthesia is for the left side on the level of the navel, for the right side it is slightly higher.—4th November. Much weakened by an attack of bronchitis and diarrhœa, concurrently with which the cicatrix of the sacral sore has broken down.—27th December. Much harassed by “jumpings” of his legs. Despite of every care and attention the bed-sores became larger and deeper.—3rd February. Reflexes in legs are now feebler.—14th. Tissues of sacrum and coccyx have been thrown off. His strength is rapidly failing.—28th. Death.

Comment.—The absences of reflexes and their return on the second day, with their subsequent exaggeration and their enfeeblement before his death, are worthy of notice in this case. The slight return of motor power after so long an interval of between three and four months, and the extreme pain attending catheterisation, are other points of interest.

(It is a matter of much regret that the sheets containing the record of the necropsy are missing from the P. M. Register.)

11. *Dislocation (?) of the 11th Dorsal Vertebra, with severe injury of the Spinal Cord.*

R. K.—, æt. 16, a general servant, was received into Bird Ward on 5th September, 1879, having tumbled backwards

through a skylight, and fallen from a height of 15 feet. She was much collapsed. She had complete motor paraplegia, and the lower limbs and the trunk were anæsthetic as high as a line about 1 inch above the level of the navel, the line being slightly higher on the left than on the right side. Reflexes were absent. She complained of great pain in the middle of the back. Retention of urine. A scalp wound 3 inches long crossed her forehead.—6th. Reaction established. Temperature, 100° F.; pulse, 112. Tongue furred.—8th. The spinous process of the 10th dorsal vertebra is unduly prominent. Temperature in armpit, 99·2° F.; between toes, temperature 100° F. She now seems slightly conscious when touched with the nib of a pen in the anæsthetic area. Reflexes still absent. Blebs on the right hallux.—11th September. Fæces voided unconsciously into the bed. Cystitis.—16th. She said when touched that her legs tingled.—18th. Not conscious when the anæsthetic area, the upper limit of which is 2 inches above the navel, is pricked with a pin, but slight reflex movements of the toes of the left foot are excitable by touching the sole.—19th. Reflexes stronger in left foot, and now slight in the right foot.—30th. The limit of anæsthesia is now about $1\frac{1}{2}$ inches lower than on the 18th instant.—October 1st. Reflexes well marked in both feet. Some return of sensibility in both lower limbs, and in the left some power of localisation of point of touch.—18th. Sensibility increased, better in the left than in the right lower limb; and in the latter localisation of point of touch is still very imperfect. Reflexes stronger in feet. Voluntary movement still absent.—20th. Urine now dribbles off. Shooting pains in loins.—30th. Slight voluntary movements in both legs first noticed.—November 10th. Sensibility, though imperfect, present over the whole front of the lower belly, before quite anæsthetic.—19th. She now recognises a difference when her legs are touched with a piece of ice and with the hot bowl of a spoon, but cannot say which of the two contacts is hot or cold.—16th December. Thermal sensitiveness is unchanged, tactile seems a little improved. But little indication of returning voluntary motor power.—On 30th December an attack of scarlatina compelled her transfer to the "Fever Hospital." (I have unfortunately been unable to trace her subsequent history.)

Comment.—Here, the relatively early return of sensibility

must be regarded as evidence that the injury of the spinal cord was a severe bruise or nip, and not a complete severance of it, affecting somewhat unequally its lateral halves. The slight projection of the spinous process of the 10th dorsal vertebra, in absence of any mobility of it, was not regarded as evidence of displacement after fracture of its base, or of the vertebral arch, but as due to a luxation of the body of the vertebra. Cautious endeavours to replace this failed. The behaviour of the reflexes should again be noticed—absent at first, they subsequently returned.

12. *Pistol-shot fracturing the 11th Dorsal Vertebra, and damaging severely the Spinal Cord. Survival.*

J. R—., æt. 23, of middle height, and dark complexion, a book-keeper, was admitted into Founder Ward on 10th March, 1885, for the consequences of a bullet-wound received $2\frac{1}{2}$ years previously. When hit he was seated on a stool; the shot was fired by a man standing 6 to 8 feet distant from him, and the barrel of the pistol was pointed downwards. After being hit he rose, walked a few paces, and then fell. He coughed up a little blood, and blood issued copiously from the wound, which was just below the inner end of the left collar-bone. He was seen almost directly by a surgeon who happened to be near. At about ten minutes after the time of receiving the injury he was found to have complete motor palsy of both lower limbs, and also anaesthesia of these members and of the trunk as high as the navel. Urine and fæces were voided involuntarily and without his consciousness.

At the date of his entrance into the Middlesex Hospital, a small, whitish scar marked the entrance wound of the bullet. No trace of exit wound was discoverable. The tip of the spinous process of the 11th dorsal vertebra was separated by a wider interval from the next spinous process above and below it, than were the intervals between the spinous processes of the other dorsal vertebrae, suggestive of a slight displacement. Above this level the sensibility of the surface was normal, whilst below it sensibility was greatly impaired, mechanical stimuli being scarcely felt, and the point touched inaccurately localised.

There was complete motor palsy of both lower limbs. These members were slightly wasted. They lay relaxed on the bed, and when lifted and dropped they fell flaccidly. Flexion of the right leg and thigh was thought on some occasions to induce slight muscular resistance. There was habitual constipation, and the rectum emptied its contents at intervals of a few days without the patient being conscious of the act of defecation. Urine was voided at intervals of average normal duration; a vague uneasiness warned him of distention of the bladder, and this sensation was followed by micturition, but he was not conscious of the flow of urine through and from the urethra, unless he saw it escaping, nor could he inhibit, even for a moment, the act when once begun. There were scars of bed-sores on the sacrum, and on the hips, and also recent bullæ on the right hallux.

Comment.—Here the evidence of a severe injury of the spinal cord at the level of the 11th dorsal vertebra is conclusive. The fact, if authentic, that the patient, after being shot, walked a few paces, proves that this injury was not a complete severance of the spinal cord by the bullet, or by a sharp fragment of the broken vertebra impelled by this; whilst the quick super-vention of the motor palsies and anæsthesia is highly suggestive of these being initially due to rapidly increasing great pressure on the lower part of the cord by blood rapidly and copiously effused into the vertebral canal, within the dural sheath and in the cord itself, which may have been bruised or grazed by the bullet. Upon this hypothesis the persistence of the nerve lesions appears referable to superinduced structural changes in the cord, such as inflammatory softening, followed by atrophy; but as a possible cause of their persistence, pressure on the cord by excessive callus about the broken vertebra or around the bullet, which lodged, cannot be excluded. The persistence of slight tactile sensibility in the palsied lower limbs, $2\frac{1}{2}$ years after the receipt of the injury, showed that even then destruction of the cord was not complete at the seat of injury. As already mentioned, the patient was seen by a surgeon on the spot. Within thirty-five minutes of the time of injury he was received into a hospital (U.S.), where he said the question of an immediate operation was discussed and negatived, and later again subsequently considered and rejected. He sought

admission into the Middlesex Hospital on account of the appearance of the blebs on the great toe, and after these healed he left. He would not entertain the idea of any surgical measure unless a guarantee could be given that it was unattended with risk, and it would certainly prove beneficial, a stipulation which obviously could not be complied with.

13. *Revolver Bullet lodged in 12th Dorsal Vertebra, having traversed Belly. Death from Hæmorrhage and Shock, on 2nd day. (Fig. 3.)*

F— G—, æt. 35, on 7th June, 1890, was shot, “à bout portant,” in a street near the hospital, with a large revolver, by a man with whom he had had an altercation. When hit he fell to the ground, and lying motionless the bystanders for a few moments thought him dead. He was taken up and brought directly to the hospital, into which he was received within a few minutes of the occurrence. The bullet had entered nearly $3\frac{1}{2}$ finger-breadths below and inwards from the left nipple, in the level of the middle of the xiphoid cartilage, where was a circular, black, ecchymosed patch, swollen and hard, 4 centims. in diameter. In the middle of this was the aperture, circular, with defect of substance, rather more than 0·5 centim. across. Lying in the aperture was a small chip of cartilage.

There were signs of great shock and distress, his face was pale, bedewed with beads of sweat; his pulse was very weak, slightly slow; and he rolled about restlessly in his bed and groaned as if in great pain—which he referred to the epigastrium. His clothes, corresponding to the wound, bore clear marks of a gun shot, fired at a very short distance. In his coat was a relatively large ragged hole, and a woollen spencer, waistcoat, shirt, and vest had each a smaller perforation. In the two first named garments the edge of the hole was distinctly singed. In the under garments the edges of the aperture were cleanly cut, as if punched. For some distance around the wound the clothing was soaked with blood.

The wound was washed with a watery solution of mercuric perchloride, dusted with iodoform, and covered with a bunch of boric charpie. Morphine hydrochlor., gr. $\frac{1}{4}$, was given hypodermi-

cally, and repeated $1\frac{1}{4}$ hours later, after which he appeared easier. As he had great thirst, small pieces of ice to suck were given him from time to time.—8th. At 12.30 a.m., being again very restless from pain, the hypodermic injection of morphia was repeated, and the dressings being found wet with blood were changed. Temperature 99.4° F.; pulse, 116. 5 a.m. Pain having again become severe he had another injection of morphia. Temperature 99.2° F.; pulse, 120. He now began to vomit, throwing up small quantities of bile-stained turbid fluid. At 10 a.m., having been easy after the last injection and quiet, he complained of very severe pain in his back, for which the hypodermic injection was repeated. At 11 a.m. his belly was found distended and tender. Respirations shallow, 40 per minute. At 1 p.m., Temperature 98.4° F.; pulse 150, weak and irregular. Respirations 56. At 2 p.m., rapidly sinking. At 3.25 p.m., death.

At the necropsy made next day the bullet was found to have struck the 7th rib, from which the chip found in the external wound had been chipped, then it had passed through the pleural sac without injuring the lung, pierced the diaphragm, traversed the left lobe of liver, curved over the lesser curvature of the stomach, grazing but not opening the viscus; grazed the abdominal aorta; furrowed the upper border of the 1st lumbar vertebra, and passing through the intervertebral disc between this and the 12th dorsal, had buried itself in the body of this latter, starring the posterior surface and causing it to very slightly bulge into the vertebral canal, but not sufficiently to press on the cord. Blood to the amount of $1\frac{1}{2}$ pints was found extravasated into the peritoneal sac.

Here there were not any symptoms suggestive of the vertebral injury. Had the patient survived longer it is not improbable that inflammation might have spread into the vertebral canal from the tissues surrounding the embedded bullet, or that pressure might have been made on the contents of the canal by callus. A clinical point of interest was the man's intense thirst, and this before the febrile elevation of temperature: it is often concurrent with large hæmorrhage.

14. *Fracture, with Displacement, of the Spinous Process of the 1st Lumbar Vertebra. No Spinal Symptoms. Recovery.*

A. G—., æt. 34, a painter, fell from a window-sill on to the pavement, a distance of about 12 feet, striking his back and head, on March 4, 1874, soon after which he was admitted into the hospital. The spinous process of the 1st lumbar vertebra was distinctly depressed, its free end lying in a plane anterior to that of the vertebra below it. No spinal symptoms. Much swelling of soft parts at the seat of injury. A scalp-wound at left of occiput. He remained in the hospital until May 5th, when he was discharged wearing a "support." He had for some time previously been able to get up and take exercise in the garden.

15. *Dislocation and Fracture of the 1st Lumbar Vertebra, &c. Recovery.*

M. A. M—., æt. 26, a short, stout brunette, a maidservant, was received into Bird Ward on 7th March, 1890, having, it was said, fallen from the window of a room in the 3rd story of a house on to the street pavement, splitting, it was said, the flag-stone on which she alighted. She was in a state of extreme shock, deadly pale, pulse scarcely perceptible, and breathing very shallow. In the lower dorsal and in the lumbar region was a large puffy ecchymosed swelling, obviously due to extravasation of blood, masking somewhat the vertebral spinous processes, but yet permitting the detection of a displacement of one of the upper lumbar (2nd ?), its tip lying distinctly in an anterior plane to that of the spinous immediately above it, which was in the same plane as those of the dorsal vertebræ. Her buttocks and her perineum were very swollen and ecchymosed, and over the coccyx was a small wound. Acute pain was felt when the ilia were forcibly pressed against the sacrum. She complained also of severe pain in the hypogastrium. She could move both her legs, and their sensitiveness did not appear to be impaired. Retention. The urine drawn off with a soft rubber catheter was bloody. She rallied very slowly. Cystitis supervened. The soft parts over the left side of the base of coccyx, where the bruise appeared to be most severe, sloughed in a limited area down to the bone, leaving a wound which closed very slowly. She remained in the hospital until 28th May,

when she was sent to a convalescent institution. When last seen, in March 1891, she had resumed her work as a domestic servant, but complained of occasional aching pain in the right loin. The spinous process of the 1st lumbar vertebra was unduly prominent, and it was also slightly displaced laterally.

Comment.—In this case the injury of the vertebral column was fortunately below the level of the lower end of the spinal cord, which itself escaped damage. The source of the blood in the urine must remain uncertain, but having regard to the closeness to the kidney of the part of the column injured, and the pain in the right renal region, the right kidney was thought to be the probable source.

16. *Fracture in the Dorso-lumbar Region. Paraplegia. Recovery.*

J. R.—, æt. 48, a carpenter, was received into the hospital on 24th November, 1873. He had half an hour previously fallen down the well of a staircase through a distance said to be 40 to 50 feet. There was great shock. Temperature, 96·4° F.; pulse, small and slow; great pallor; and great thirst. He had absolute motor palsy, but no marked anæsthesia, of both lower limbs, from which also plantar and other reflexes were absent. He complained of great pain at the “bottom” of his back. At the junction of the dorsal and lumbar segment of the vertebral column was a puffy swelling, beneath which a crepitus, as of fracture, was perceptible. Breathing mainly diaphragmatic, with some co-operation of the upper intercostal muscles. Retention.—25th. A sense of constriction round the left half of the chest. Pains in the back radiating thence down both legs into the toes.—26th. He can now draw up both his legs, and move the toes.—28th. Extensive ecchymoses have come out, overspreading the sacrum, loins, and the lower part of the posterior surface of the thorax. Cystitis supervened. He continued long plagued with pains in the back and legs, and with “burning feelings” in those parts, as the heels and the sacrum, on which there was greater pressure. His legs slowly recovered power, and on 2nd February he was able to leave his bed for a short time, wearing a gypsum jacket.—On 16th February he left the hospital, able to walk a few steps with help. (His further history is unknown to me.)

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